

# Chapter 09

## Lecture Outline\*

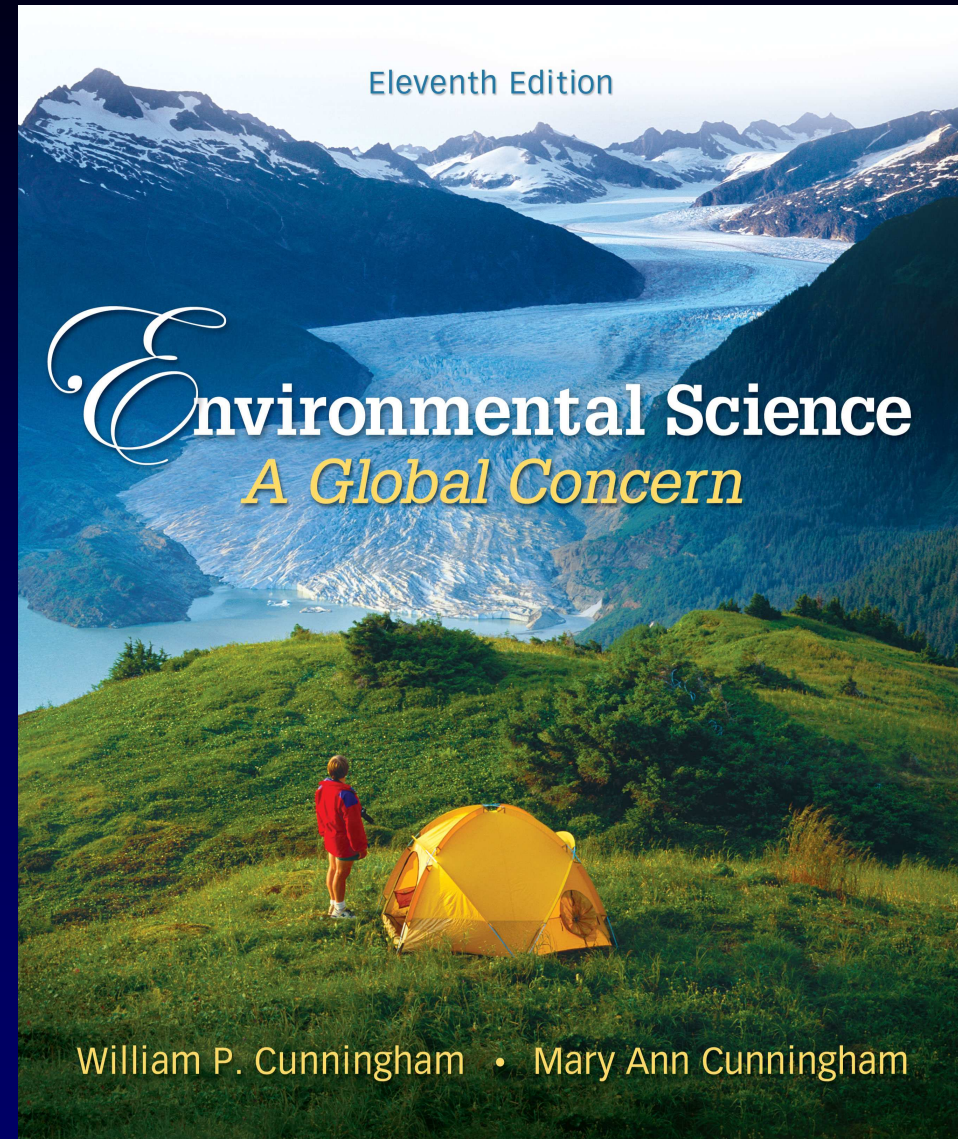
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**\*See PowerPoint Image Slides for all figures and tables pre-inserted into PowerPoint without notes.**





# Food and Hunger

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# Outline

- Food and Nutrition
- Famines and Overeating
- Food Pyramids and Eating Right
- Avoiding Nutritional Problems
- Key Food Sources
- Farm Policy
- Sustainable Agriculture
- Food Production and Land Use Policies
- The Green Revolution
- Genetic Engineering

# Food and Nutrition

- World food supplies have more than kept up with human population growth over the past two centuries.
  - ❖ During the past 40 years, population growth has averaged 1.7% per year, while food production increased an average 2.2%.

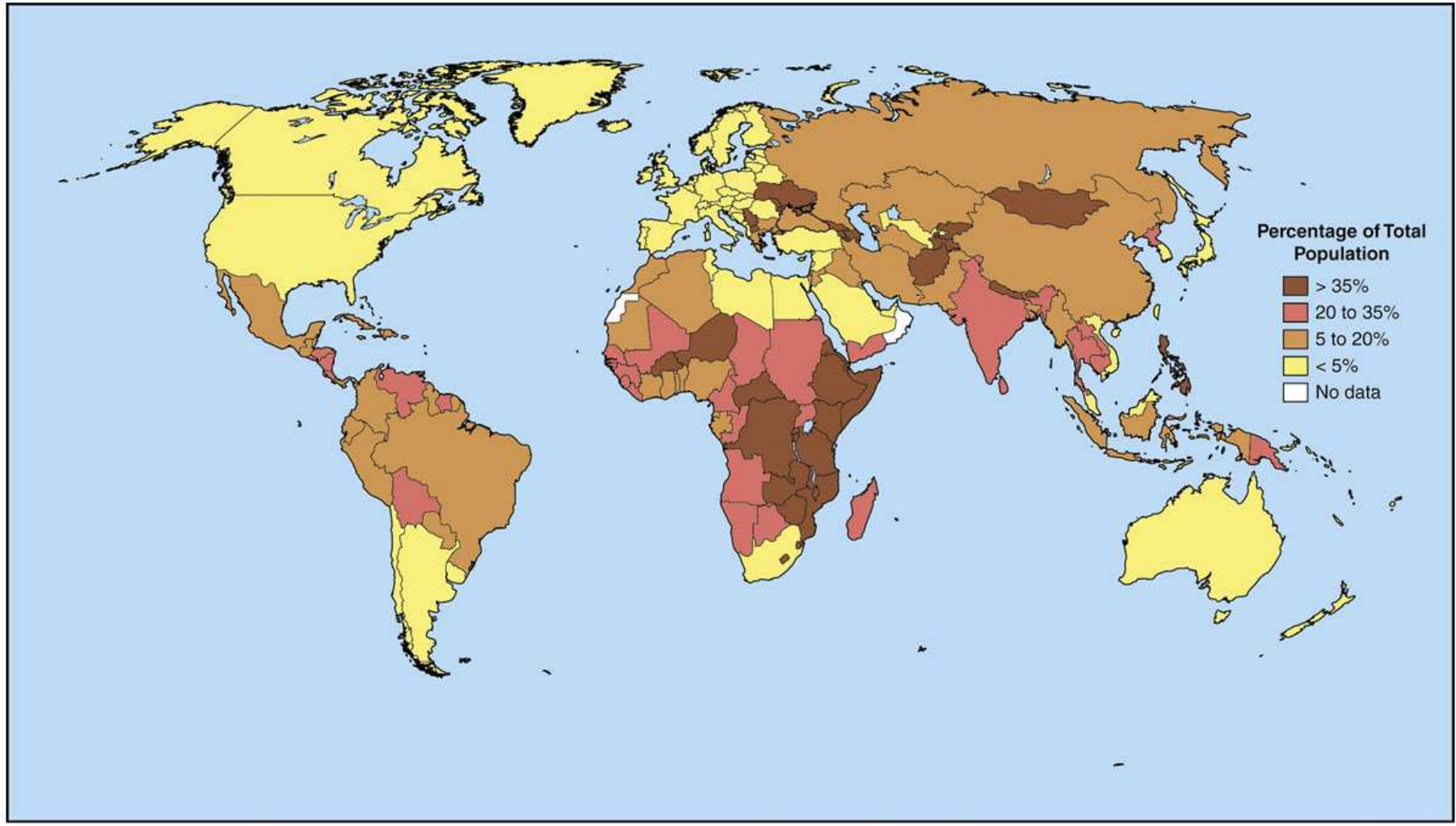


# Chronic Hunger and Food Security

- In 1960, 60% of the population of developing countries was considered **chronically undernourished**.
  - ❖ Today it is less than 14%.
- Poverty is the greatest threat to **food security** (Ability to obtain sufficient food on a daily basis).
  - ❖ Operates on multiple levels
  - ❖ Providing land grants, credit and education to women, who do 50-70% of the farm work in developing countries, would be an important step toward food security in these countries.

# Hunger Around the World

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# Causes of Famines Usually Social & Political

- **Famines** are characterized by large-scale food shortages, massive starvation, social disruption, and economic chaos.
  - ❖ Mass migrations often occur because productive capacity has been sacrificed.
  - ❖ Environmental conditions are an immediate trigger.
  - ❖ However, armed conflict and political oppression, commodity hoarding, price gouging, wars and poverty are commonly underlying causes.

# Famines

- Aid policies of rich countries often serve to distribute surplus commodities and produce a feeling of generosity BUT
  - ❖ Herding people into feeding camps is typically counterproductive.
  - ❖ Many die on the way, others die in epidemics or from violence, and being away from their land, they are not there to replant their crops when weather returns to normal.



## Overeating is also a Growing Problem

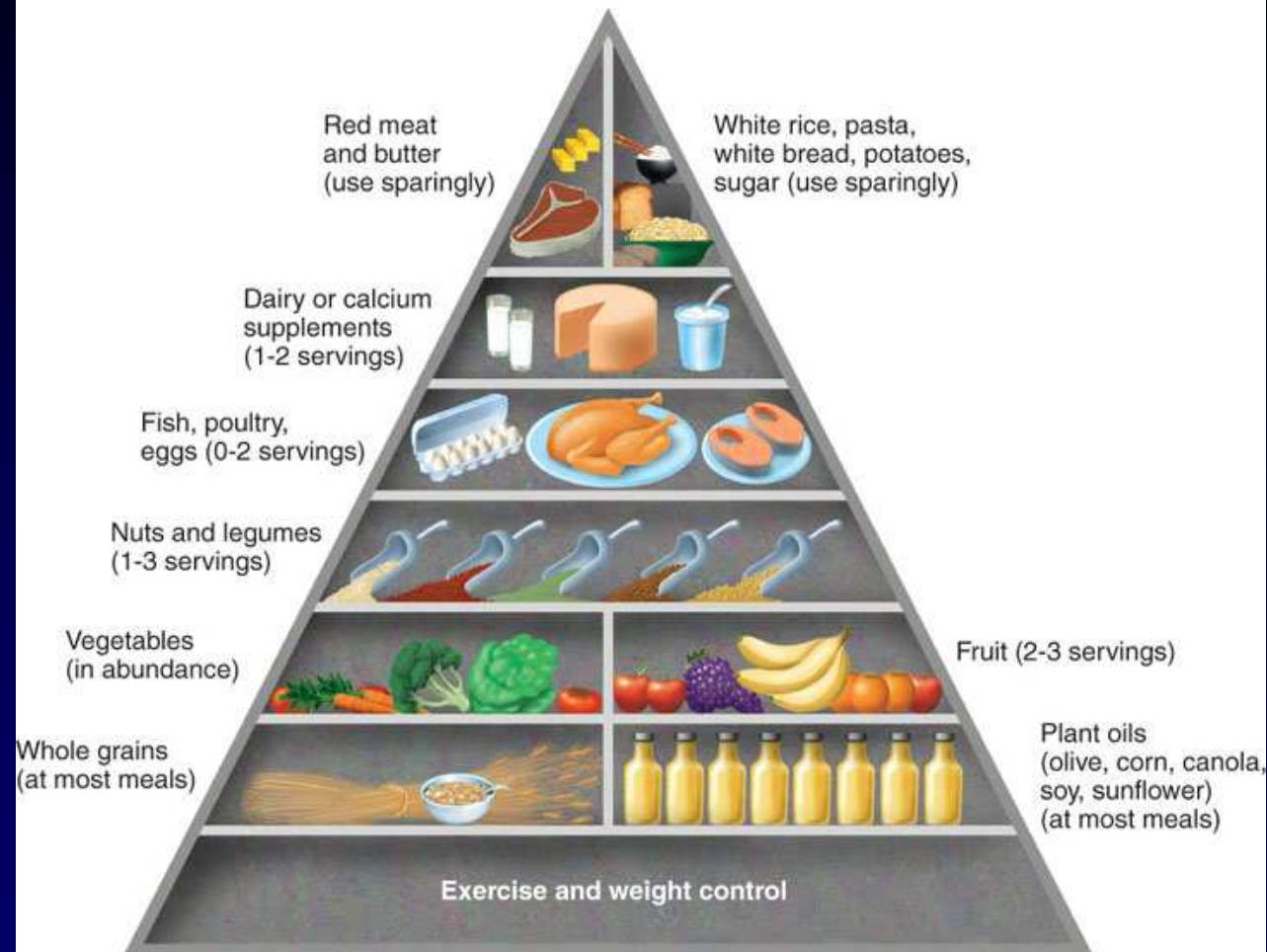
- In the US and other developed countries, highly processed foods rich in sugar and fat have become a large part of the diet.
- 64% of Americans are overweight.
- 33% of Americans are **obese**, meaning they are 20% or more over their ideal weight or have a body mass index of  $>30\text{kg/m}^2$
- Being overweight increases your chances of hypertension, diabetes, heart attack, stroke, arthritis, respiratory problems and cancer.
- Diet and lifestyle changes are needed to combat the problem.

## We Need the Right Kinds of Food

- Generally, eating a good variety of foods should give you all the nutrient you need.
- However, Americans tend to consume too many simple sugars and starchy foods.
- Researchers at Harvard University recommend following a new dietary pyramid which encourages reducing red meat and starchy foods and emphasizes consumption of nuts, legumes, fruits, and whole grains.
- This Harvard Diet also encourages substituting unsaturated plant oils in place of saturated trans fats and adding moderate exercise to your routine.

# Harvard Dietary Pyramid

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Harvard food pyramid

Data from Willett and Stampfer, 2002

# Vitamins Can Prevent Illness

- **Malnourishment** - nutritional imbalance caused by a lack of specific dietary components or an inability to absorb or utilize essential nutrients
  - ❖ 3 billion people suffer from vitamin, mineral or protein deficiency.
  - ❖ Results in illness, reduced mental capacity, developmental abnormality, stunted growth, death



# Nutritional Problems

- Iron deficiency is the most common dietary imbalance in the world.
  - ❖ Leads to anemia, insufficient hemoglobin in the blood
    - Increases risk of death from hemorrhage in childbirth and affects development
      - Red meat, eggs, legumes, and green vegetables are all good sources of iron.

## Nutritional Problems

- Lack of iodine leads to goiter as well as stunted growth and reduced mental capacity.
- Lack of vitamin A affects as many as 140 million children and 350,000 go blind each year.

# Protein Deficiency Diseases

- **Kwashiorkor** - occurs mainly in children whose diet lacks high-quality protein
  - ❖ Reddish-orange hair, bloated stomach
- **Marasmus** - “To Waste Away” - caused by a diet low in protein and calories
  - ❖ Very thin, shriveled



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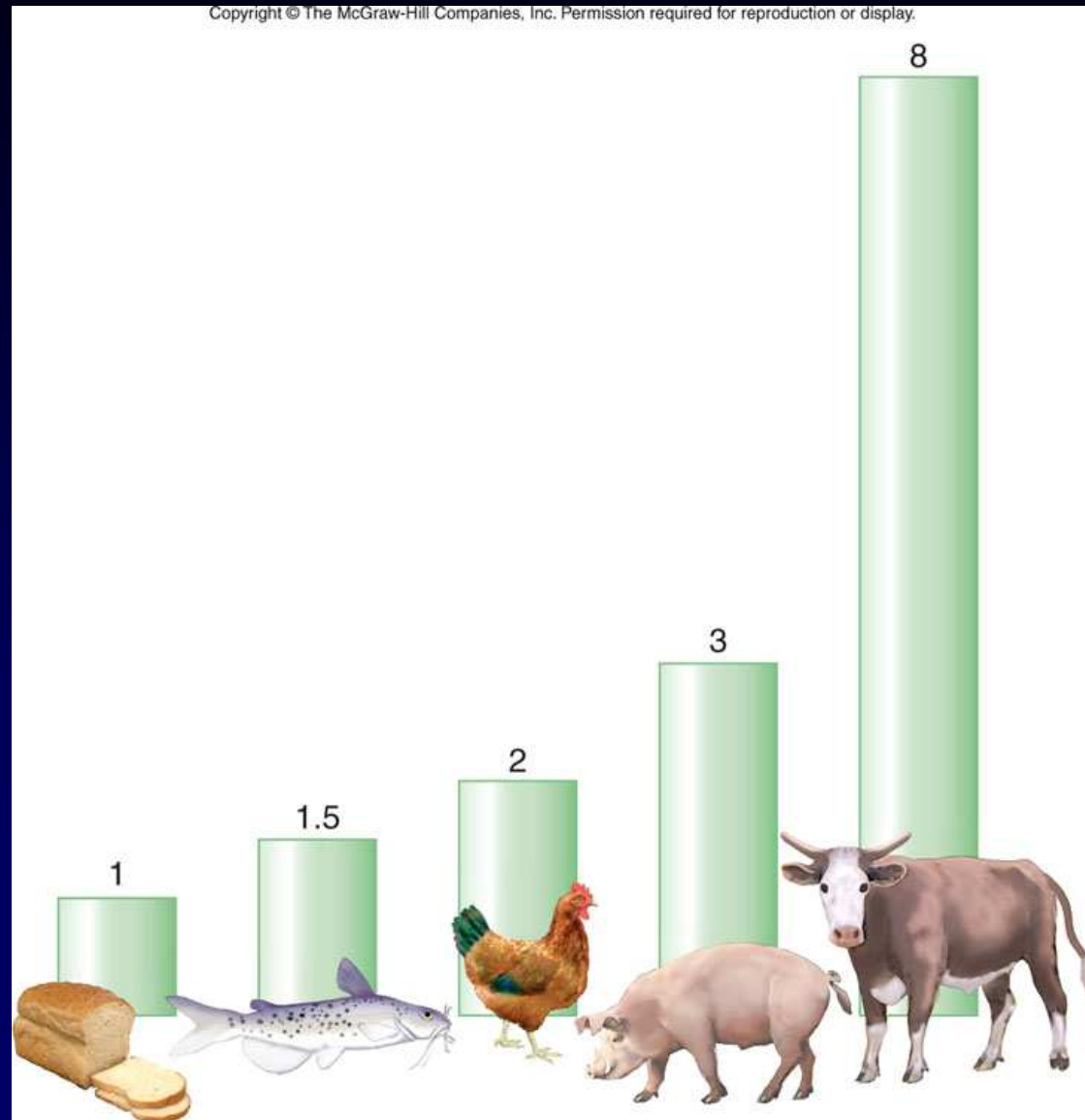
# Key Food Sources

- ❖ Worldwide, three crops deliver the majority of the needed nutrients to humanity:
  - **Wheat, Rice and Corn**
- ❖ 1900 million metric tons are grown each year globally.
- ❖ In addition, potatoes, barley, oats and rye are staples in cool, moist climates.
- ❖ Cassava, sweet potatoes, and other roots and tubers are staples in warm, wet climates.

# Costs and Benefits of Meat Production

- In developed countries, meat consumption has risen from 10kg/person/year in 1960 to 26kg/person/year today.
- Meat consumption in the US has risen from 90kg/person/year to 136kg/person/year in the same time interval.
- Meat is a concentrated, high-value source of protein, iron, fats and other nutrients.
- Meat production is a good indicator of wealth as meat is expensive to produce:
  - ❖ ie. It takes  $> 8$ kg of grain to produce 1kg of beef.

# Grain Needed to Produce Various Meats



# Agricultural Innovations in Meat Production

- **Confined Animal Feeding Operations** where animals are housed in giant enclosures and fed diets of soy and corn for rapid growth.
- Such operations are common in the US, Europe and China.
- New breeds of livestock have also been developed which produce meat rapidly with shorter turn-around times.
- Heavy use of antibiotics allows producers to limit the spread of disease among animals being raised in such high densities.



## Meat Production is Energy-Intensive

- It takes at least 16x as much fossil fuel to produce a kg of meat as it does a kg of grain.
- UN Food and Agriculture Organization experts estimate that livestock produce 20% of the worlds emissions of greenhouse gases.
- Reducing your meat consumption by 1/5 is would reduce your energy consumption more that switching from a standard car to a hybrid!

# Seafood

- Seafood is an important protein source.
- Since 1989, 13 of the 17 major fisheries in the world have declined or become commercially unsustainable.
- If current practices continue, the world's fisheries will be exhausted by 2048.
- Huge boats sweep large portions of the ocean and kill birds, turtles, and other species as “by-catch”.
- Aquaculture (growing aquatic species in pens) is providing an increasing share of the world's seafood.

# Seafood

- Aquaculture supplies food, but it
  - ❖ uses wild populations to stock and feed captive populations
  - ❖ destroys mangrove forests and wetlands used as nurseries for all marine species
  - ❖ allows the spread of disease
  - ❖ releases large quantities of feces, antibiotics and other pollutants
- Polyculture of mixed species of herbivores or filter feeders can help.

## Increased Risks of Meat Production

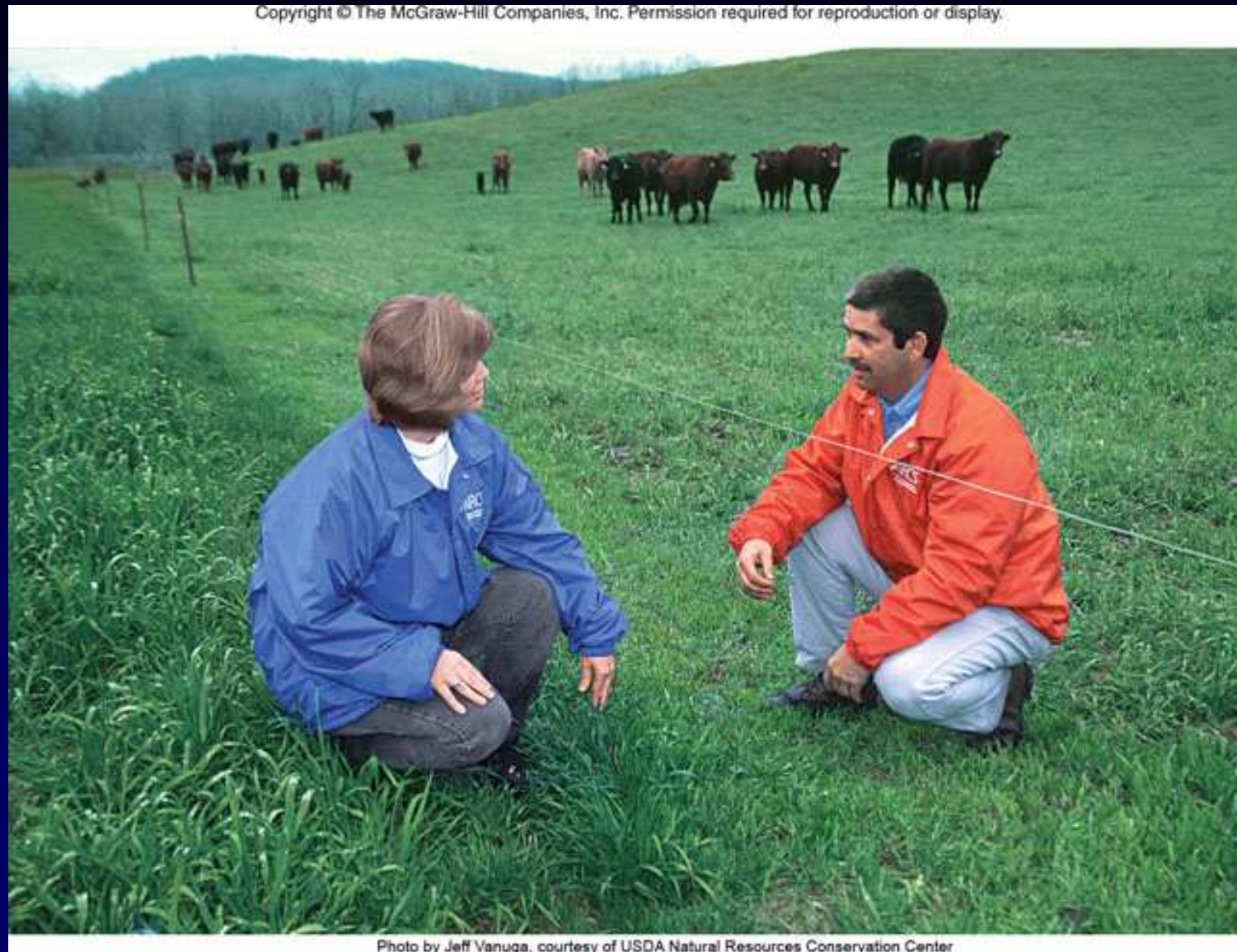
- Converting land to soy and corn production for animal feed increases soil erosion.
- Bacteria-laden manure can escape from feed lots into the environment causing damage.
- Increased use of antibiotics leads to more antibiotic resistant pathogens.



## Food Production can be Sustainable

- There is growing interest in alternative agriculture that can reduce the use of energy, antibiotics and other environmental costs associated with modern agriculture.
- Fruits, vegetables, meat, dairy and eggs can all be produced in more sustainable ways.
- Rotational grazing of cattle on grass instead of feeding them grain and the use of organic farming techniques can be more environmentally sustainable.

# Rotational Grazing



# Food Production Policies

- Farm subsidies in many countries are protected by powerful political and economic interests.
  - ❖ Agricultural subsidies encourage surpluses and allow American farmers to sell products overseas at prices below production costs.
  - ❖ This can distort global markets and cripple production in developing countries.

## Policies can Protect the Land

- The US has an effective Conservation Reserve Program that pays farmers to take highly erodible land out of production.
- This program prevents the loss of 450 million tons of topsoil as well as protecting 270,000 km of streams and storing 48 million tons of carbon every year.
- Modifying government subsidies to encourage farmers to produce fruits and vegetables for local consumption rather than grains could provide a “whole farm” safety net.



# The Green Revolution and New Crops

- Most of the world's food comes from only 16 species.
- New crops possible
  - ❖ Winged bean
  - ❖ Tricale, a hybrid between wheat and rye



# Green Revolution Produced Increased Yields

- Most major improvements in farm production have come from technological advances and modification of a few well-known species.
  - ❖ Corn yields jumped from 25 bushels per acre to 130 per acre in last century.
    - Most of this was gain accomplished through conventional plant breeding
- **Green Revolution** started over 50 years ago with the production of tropical, semi-dwarf, wheat and rice strains which are now grown in developing countries around the world.



# Semi-Dwarf Wheat



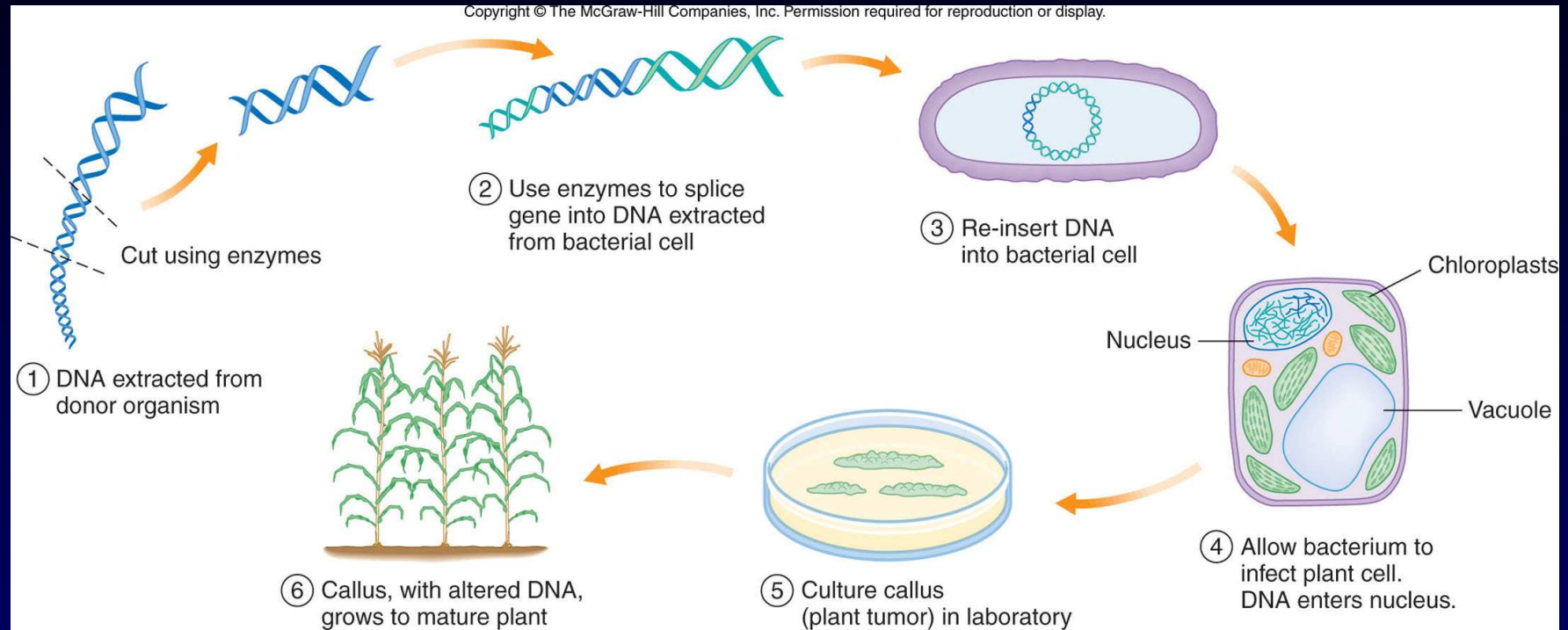
# Shortcomings of the Green Revolution

- Green revolution plants are “high responders” which only show increased yields if they have fertilizers and protection from pests. If these are lacking, they may not produce as well as traditional crops.
- Poor farmers who cannot afford the costs of fertilizer, pesticides and hybrid seeds may be left out of the green revolution.
- Efforts are underway to create new crops and technology which are suited for tropical climates and in anticipation of global climate change.

# Genetic Engineering Produces New Crops

- **Genetic engineering** - removes DNA from one organism and splices it into the chromosomes of another. Produces **genetically modified organisms (GMOs)** with new traits.
  - Can produce crops with pest-resistance and wider tolerance levels to frost, drought, low nutrient soils, salty soils, etc.
  - Can improve protein or vitamin content of crop
  - Can incorporate oral vaccines into foods such as bananas for use in developing nations
  - Animals can be modified to grow faster or produce pharmaceuticals in their milk.

# Gene Transfer Techniques





# Concerns Regarding GMO's

- Opponents worry that
  - ❖ GMOs might produce superweeds resistant to pesticides.
  - ❖ Native biodiversity may be reduced.
  - ❖ Novel toxins might be created.
  - ❖ Technology may only be available to the rich, making family farms uncompetitive and driving poor nations further into poverty.
- You are already eating GMO's: 60% of processed food in the U.S. now contains GMO's.

# Pest Resistance and Weed Control

- Biotechnologists have recently created plants containing genes for endogenous insecticides.
  - ❖ A gene from the bacterium *Bacillus thuringiensis* (Bt) makes toxins that are lethal to butterflies and beetles. These genes have been transferred into corn, potatoes and cotton. Reduces pesticide use and increases yield.
  - ❖ Concern has arisen over several points.
    - Spread of genes into wild populations leading to resistance in pests
    - Effect on nontarget species



# Transgenic Crops

- Genetically modified organisms are also called transgenic organisms.
- Transgenic crops can be engineered to tolerate high levels of pesticides.
  - ❖ Roundup Ready and Liberty Link are two of the most popular. Crops can grow in the presence of the pesticides (called Roundup and Liberty) while weeds within the field are killed.

# Is Genetic Engineering Safe?

- Environmental and consumer groups have campaigned against transgenic organisms.
  - ❖ “Frankenfoods”
  - ❖ European nations have bans on GMOs.
- U.S. Food and Drug Administration declined to require labeling of foods containing GMOs.
  - ❖ New varieties are “substantially equivalent” to related traditionally-bred varieties.

# Is Genetic Engineering Safe?

- GMOs tested so far do not survive well in the wild and are no more invasive than unmodified plants.
- Worry that genetically modified animals will escape captivity and outcompete their wild relatives.  
(Salmon with added growth hormone gene grow 7X faster than their wild counterparts.)
- We should err on the side of safety.
- Will GMOs help feed the world or lead to more economic disparity?